

**A PRELIMINARY SURVEY
OF THE BATS OF THE
DEERLODGE NATIONAL FOREST
MONTANA**

1991

**Final Report
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by

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for the

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INTRODUCTION

There are more species of bats worldwide than any other group of mammals except rodents, totalling some 950 species with nearly worldwide distribution (Hill and Smith 1984). Most are considered beneficial to man, and play key ecological roles as plant pollinators and voracious insect eaters, yet as a group few mammals have been more misunderstood. Today, many species of bats are potentially threatened with extinction, and most bat populations have been reduced due to direct attempts at extermination, indirect loss through pesticide poisoning and roost disturbance, and loss through degradation of food sources and habitat loss or alteration (Fenton 1992).

The National Forest Management Act of 1976 and United States Forest Service (USFS) policy require that Forest Service land be managed to maintain viable populations of all existing native and desirable non-native plants, fish, and wildlife (FSM 2601.2). A viable population has the size and distribution of reproductive individuals to ensure continued existence of the species throughout its existing range (FSM 2605). Species recognized by the Forest Service as needing special management in order to meet this objective are those designated under the Endangered Species Act as threatened or endangered, those candidate species under consideration for such designation, and those classified as Sensitive Species. Sensitive Species are plant and animal species identified by the Regional Forester for which population viability is a concern as evidenced by a significant downward trend in population numbers or habitat capability that would

reduce a species' existing distribution (FSM 2670.5).

Additionally, the Endangered Species Act Section 7 (a)(2) mandates the assurance by any federal agency that any of its actions "is not likely to jeopardize the continued existence of any endangered or threatened species or result in the destruction or adverse modification of (its) habitat" (Finch 1992).

There are presently 14 species of bats in Montana (Thompson 1982). Three of these, the Townsend's big-eared bat (*Plecotus townsendii*), the Spotted bat (*Euderma maculatum*), and the Pallid bat (*Antrozous pallidus*) are listed as sensitive species by USFS Region 1 (Mumma 1991). In addition to these three species, the Fringed myotis (*Myotis thysanodes*) and the Northern long-legged myotis (*Myotis septentrionalis*) are also listed as species of special concern by the Montana Natural Heritage Program (Genter 1993). Several other species have localized distribution in Montana. Relatively little work has been done in the state to inventory species' distributions, densities, and population trends to date.

As the U.S. Forest Service has a responsibility to manage for species viability on Forest lands, as required by the previously mentioned legislation and rules, and as relatively little is known concerning bats in Montana, and several Montana species are listed as sensitive by the USFS and by the Montana Natural Heritage Program, the biologist for the Deerlodge National Forest in southwestern Montana

contacted the Montana Natural Heritage Program director to discuss the possibility of developing baseline data on the occurrence, distribution, relative density, and habitat use of bats on the Forest. The results of the first year of study are presented here.

ACKNOWLEDGEMENTS

Field work for this study was performed by Tom Butts with the assistance of Wendy Wilson and Jeremy Butts. Dave Genter of the Montana Natural Heritage Program provided direction, suggestions, editing of reports, field assistance, equipment, and bat identification. Jina Mariani, Deerlodge National Forest, Butte, provided the impetus for the study, funding, a vehicle, and editorial comments on the final report.

METHODS

Equipment

Mist nets: Braided nylon mist nets, in 18, 30, and 36 foot lengths, (50 denier/2 ply; 1 1/2 inch mesh) were used to capture bats (Kunz and Kurta 1988). Mist nets were strung on sectional aluminum poles made from electrical conduit, cut to 5 foot lengths, each with a connector at one end, so a net pole could be fashioned to any desired height. Poles used for this study were two or three lengths high (10 to 15 feet). Poles were held in place with ropes tied to trees, rocks, or branches. Mist nets were deployed across forest trails, across the narrower stretches of slow moving streams and smaller pools, and adjacent to the shoreline of lakes and larger ponds (Kunz and Kurta 1988).

Harp Trap: A modified collapsible harp trap (Kunz and Kurta 1988, Tuttle 1974) was constructed using 3 inch PVC pipe for the frame and 10 pound monofilament fishing line strung between the vertical members of the trap. The double-frame trap was used at the mouths of caves and adits (Kunz and Kurta 1988).

Bat detectors: Tunable Broadband ultra-sonic bat detectors were used to detect night-time bat activity. If a single detector was being used it was tuned to 40 kHz when walking a transect. When a bat was detected, the dial of the detector could be manipulated to find the high and low range of the detected bat (if there was time,

which there generally was not). With experience, the activity of the bat (cruising, searching, or feeding) and the genus of the bat could be determined by the sound, duration, and intensity of the detected bat echolocations (Fenton 1988, Fenton and Bell 1981). Detections were recorded on field forms by time, frequency monitored, and species (if known or suspected) (See Appendix I for example of field form used).

Temperature in degrees fahrenheit was recorded in most adits and cave using a Taylor Pocket thermometer. Relative humidity was recorded at these sites using a Princo Pocket sling psychrometer.

Bat identification

Once captured in a mist net or harp trap, bats were carefully removed. Species of the bat, sex, age (juvenile or adult), reproductive condition (females: lactating or non-lactating; males: scrotal or non-scrotal), and select measurements (forearm length, tibia length) and other identifying characteristics and measurements such as ear length, pelage coloration, etc., were recorded on field forms. Methods of determining sex, age, and reproductive condition are from Anthony (1988) and Racey (1988). Weight was recorded using a Pesola spring scale (50g X .5g) and measurements were taken using a dial caliper and recorded to the .5 millimeter. Bats were identified using one of several dichotomous keys. The most useful were:

Bats of America Barbour and Davis 1969

The Mammals of Montana Hoffman and Pattie 1968

Handbook of Canadian Mammals van Zyll de Jong 1985

Most bats were released after data were recorded, though if there was a question of identification, or if the bat was considered unusual for the locality or habitat, the bat was collected to be verified later by a competent authority.

Site Selection

The following criteria were used in selecting sites to survey bat distribution and habitat use on the Deerlodge National Forest:

- 1) the location and survey of caves and adits on the Forest was a top priority;
- 2) representative habitats on the Forest were to be surveyed;
- 3) surveys were to be made throughout the Forest, and;
- 4) surveys were to be completed within a timeframe dictated by bat behavior: at some time, typically in September, bats would either hibernate or migrate out of the study area.

The Forest was divided into three broadly defined zones; the Phillipsburg and Anaconda area, the Boulder and Basin area, and the

Butte area. Though habitats throughout the Forest were to be sampled, the highest priority was assigned to the Phillipsburg/Anaconda zone due to the higher number of caves and adits occurring within it, and the greater variety of habitats.

Caves and adits were located by consultation with Forest Service personnel, knowledgeable "cavers," "locals," and existing literature, particularly Campbell's (1978) Caves of Montana.

Other survey sites were chosen using the afore-mentioned criteria. Once a general area was selected, the specific site was chosen that appeared to have potential roosting sites nearby, such as older trees, fractured rock, old buildings, or known caves or adits. If water was nearby, specific sites to set up mist nets were generally selected that crossed the slowest moving stretches of streams or pools.

Caves and Adits

When a cave or adit was located, it was searched for evidence of bat use (bats, droppings, characteristic odor) and the location, extent, potential for bat use, temperature, humidity, and other pertinent data were described on field forms.

Caves or adits that were potentially used by bats were surveyed by setting up one or more mist nets at or near the opening, or a harp trap within the entrance, shortly before dark, and monitoring the

nets throughout the night. Mist nets were collapsed shortly before dawn. An observer also used one or more bat detectors at the entrance, beginning at dusk and staying at least an hour, and then until there was no bat activity for more than 30 minutes.

Habitat Use Surveys

Once a site was selected, from two to five mist nets were set up in the evening across trails, next to lakeshores, and across streams or ponds (Kunz and Kurta 1988). Nets were not raised into final position until about one-half hour after sunset to avoid catching birds. Depending on the site, the height of the bottom of the net above ground or water varied from less than a foot to 6 feet. Nets were checked at least every hour until after midnight, then again between one hour, and one-half hour before sunrise. Nets were taken down one-half hour before sunrise to avoid catching birds.

One or two walking transects were conducted at each site, depending upon available personnel. Beginning approximately one-half hour after sunset, and lasting for one hour, a transect was walked through habitat representative of the area, using one of the bat detectors. All bats heard were recorded as "cruising, searching, or feeding," depending on activity, by species if identifiable, and by time period.

A few transects were run during the middle of the night (between 1 AM

and 4 AM), or before sunrise, but so few bats were recorded that this practice was abandoned.

Habitats sampled for bat activity were broken into several habitat components for analysis. The components were:

<u>COMPONENT</u>	<u>CODE</u>
Dense lodgepole pine forest	Lpp
Mixed hardwoods	Mh
Mature Douglas fir	DF
Sub-apine fir/limber pine	SF
Clearcuts nearby	CC
Lake nearby	La
Rock outcrops nearby	Ro
Cave/Adit nearby	Ca
Riparian (willow, alder, aspen)	Ri
Beaver ponds nearby	Be

Sites were assigned codes determined by habitat components at or near that site, and bat occurrence and relative density (measured by bat passes recorded per hour of walking transect) using various habitats was determined.

Mixed hardwoods were primarily cottonwoods and/or aspen stands. Mature Douglas fir stands consisted of trees generally 18 inches diameter at breast height (DBH). "Nearby" habitat components were within 1/4 mile (440 m) of the survey sites.

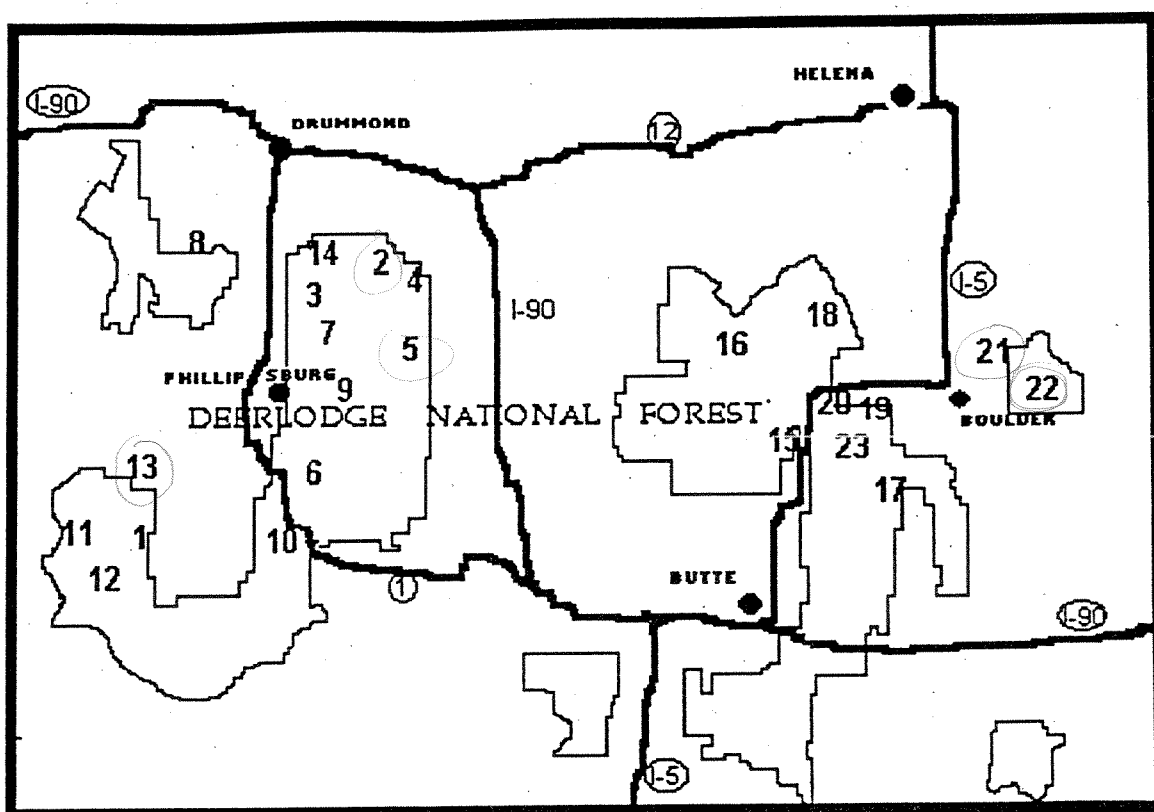
RESULTS

Habitat Use Surveys

Twenty-three sites on the Deerlodge National Forest were visited one or more times (Figure 1), and at least one walking transect was run at each of these sites. At some sites two one-hour transects were run in the evening, at two sites transects were run after midnight, and at two sites transects were run 1 hour before dawn. One site was visited 3 times, and two were visited twice. Mist nets were set up at 19 of these 23 sites (Table 1), and the harp trap was employed at one site (twice) on the Deerlodge National Forest.

No bats were heard during any 1 hour transect run after midnight. In 30 hours of transect run before midnight, 33% recorded no bats, 53% recorded between one and 9 bats, and 10% recorded more than 21 bats in one hour (Table 1).

Habitat components of sites with high bat activity (more than 10 bat passes per hour), moderate bat activity (between 5 and 9 bat passes per hour), and low bat activity (less than 5 bat passes per hour) were analyzed to isolate significant features of habitat used by bats on the Forest. If more than one transect was run at a site, the transect with the most passes per hour was used for site classification. The records of bat passes per hour for Queen's Gulch and Muskrat Creek were lost. As 10 bats were captured at Queen's Gulch in one evening, the most at one site on the Deerlodge National



- 1) WEST FORK CAVE
- 2) THE CRATER
- 3) BOULDER CREEK
- 4) DONEY LAKE
- 5) ABOVE ROCK CREEK LAKE
- 6) ECHO LAKE
- 7) SWAMP GULCH
- 8) HENDERSON CREEK
- 9) FRED BURR LAKE
- 10) HAIRY LIP CAVE
- 11) CRYSTAL CREEK C.G.
- 12) SAND BASIN
- 13) ROCK CREEK
- 14) MAXVILLE CAVE
- 15) BISON CREEK
- 16) BOULDER RIVER
- 17) BEAVER CREEK
- 18) NORTH OF BASIN
- 19) BLUEBELL MINE
- 20) ADIT #2 BERNICE
- 21) MUSKRAT CREEK
- 22) QUEEN'S GULCH
- 23) LITTLE BOULDER RIVER

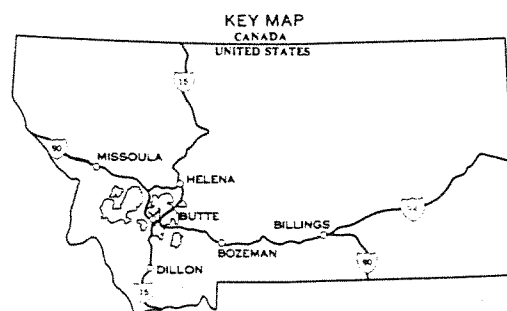


Figure 1: Map of Deerlodge National Forest and Survey Sites, 1991.

Site	Hours	Trap	Habitat components	Bat passes per hour	Bats captured	Species
West Fork Cave	1	0	Ca, Ro, Ri	0	-	
The Crater	3	3	Ca, Ro, Ri, DF, CC	8.5, 1	1	Yuma myotis
Boulder Creek	2	1	Ri, Ca, Mh, DF	2.0	-	
Doney Lake	2	1	La, Lpp, CC	0.8	-	
above Rock Creek Lake	2	1	Ri, Ro, DF	41.3	9	Little brown bat, Hoary bat, Yuma myotis, Long- eared myotis
Echo Lake	1	1	La, Lpp	5	-	
Swamp Gulch	1	1	Lpp, Ri, Be, SF	0	-	
Henderson Creek	1	1	Ri, Mh, DF, Be	5	-	
Fred Burr Lake	1	0	La, Lpp, SF	0	-	
Hairy Lip Cave	2	1	Ca, CC, Lpp	6	-	
Crystal C.G.	2	1	Ri, Ro, Mh, Lpp, DF, Be	30.2	-	
Sand Basin	2	1	Ri, Ro, Lpp, CC	7.7	-	
Rock Creek	2	1	Ri, Ro, Be, Mh, DF	5.12	1	Silver-haired bat
Maxville Cave	1	1	Ca, Ri, DF	0	-	
Bison Creek	2	2	Ri, Ca, Mh, Lpp, Be	29.7	-	
Boulder River	2	1	Ri, Mh, Lpp	4.0	-	
Beaver Creek	1	1	Ri, Ro, Mh, Lpp	0	-	
North Basin	1	0	Ri, Ro, DF	0	-	
Bluebell Mine	1	1	Ad, Ri, DF	0	-	
Adit # 2, Bernice	2	1	Ad, Ri, DF	0	-	
Muskrat Creek	1	1	Ri, DF, Lpp	?	1	Long-eared myotis
Queen's Gulch	1	1	Ri, Ro, DF	+20	10	Long-eared myotis Big brown bat
Little Boulder River	1	0	Ri, Ro, Mh, Lpp, DF	0	-	

Table 1. Survey sites and bat survey data, 1991.

Forest during 1991 surveys, high activity was presumed. Muskrat Creek was not used in the following habitat analysis.

Five of 23 sites surveyed had high activity. Two of these sites, Queen's Gulch and above Rock Creek Lake, were along small streams in mature Douglas Fir forest with nearby rock outcrops (Table 1). The other three were also near streams, had somewhat nearby rock outcrops, nearby beaver ponds, and nearby mature hardwoods (Bison Creek, Rock Creek, and Crystal Creek Campground).

Sites with moderate bat activity included the Crater, Doney Lake, Hairy Lip Cave, Echo Lake, Henderson Creek, and Sand Basin (Table 1). Two of these sites had a cave nearby (both with clearcuts nearby as well), two had a lake nearby (one with a clearcut nearby), and two were along small streams with riparian vegetation. One of these, Henderson Creek, had all of the components of the sites with high bat activity (mature hardwoods, beaver ponds, Douglas fir), and the other had rock outcrops and clearcuts nearby.

The number of sites surveyed that contained a given habitat component, and the number and percentage of these sites that had high or moderate bat activity is shown in Table 2. For instance, 11 sites had rock outcrops nearby. Of these 11 sites, five had high bat activity (45% of the sites with rock outcrops), and 2 had moderate activity (18% of the sites that had this component). By deduction,

Habitat component	# of sites surveyed	# with high activity	% with high activity	# with moderate activity	% with moderate activity
Rock outcrops	11	1	45	2	18
Caves/adits	7	0	0	2	29
Riparian	18	5	28	3	17
Beaver ponds	5	3	60	1	20
Douglas fir	12	4	33	2	17
Clearcuts	4	0	0	4	100
Lodgepole pine	11	2	18	4	36
Lakes/ponds	3	0	0	2	67
Mature hardwoods	8	3	38	1	13
Riparian/Doug. fir and/or Mat. hrdwd.	15	5	33	2	13
Riparian/Rock out.	11	5	45	2	18

Table 2: Number and percentage of sites with high and moderate bat activity for a given habitat component.

* * *

37% of the sites with rock outcrops had low bat activity. Habitat features in which one-third or more of the sites with those features had high bat activity were: beaver ponds (60%), rock outcrops (45%), mature hardwoods (38%), and Douglas fir stands (33%). No high activity sites were ever found near caves or adits, or near lakes.

Moderate bat activity was associated with the following components at least one-third of the time that the component was available: clearcuts (100%), lakes (67%), and lodgepole pine stands (36%) (Table 2).

Table 3 shows the percentage of high and moderate bat activity sites

Relative Bat activity	Rock outcrops	Caves/adits	Riparian	Beaver ponds	Douglas fir	Clearcuts	Lodgepole pine	Mature hardwoods	Old buildings
High	100	0	100	60	80	0	40	0	66
Medium	33	33	50	17	33	66	66	33	17
Low	36	45	82	18	55	0	45	9	36

Table 3. Percentage of sites with high, moderate, and low bat activity featuring a given habitat component (i.e 100% of sites with high bat activity were near rock outcrops).

* * *

containing a given habitat component. For instance, 100% of the sites with high bat activity had rock outcrops nearby, and 100% were in riparian areas. No high activity sites were near caves or adits, but 33% of the moderate sites were. No high activity sites were near lodgepole pine stands, or near lakes, but one-third of the moderate activity sites were near lakes and two-thirds were near clear-cuts (Table 3).

Bat species captured

Bats were captured at only five of the 19 sites that mist nets were

used on the Deerlodge National Forest. One bat was caught in the harp trap at The Crater, one bat in a mist net over a channel near the main fork of Rock Creek, and 9 bats in mist nets upstream from Rock Creek Lake west of Deer Lodge. One bat was captured in a mist net on Muskrat Creek east of Boulder, and 10 bats were captured in nets placed in Queen's Gulch in the Elkhorns. Location, species, sex, and weight of bats captured on the Deerlodge National Forest in 1991 is listed in Table 4.

There were six species of bats representing four genera recorded on the Deerlodge National Forest during surveys in 1991. These were the Little brown bat (*Myotis lucifugus*), the Long-eared myotis (*Myotis evotis*), the Yuma bat (*Myotis yumanensis*), the Big brown bat (*Eptesicus fuscus*), the Hoary bat (*Lasiurus cinereus*), and the Silver-haired bat (*Lasionycterus noctivagans*) (Table 4).

Location	Species	Sex	Wt (gr.)	Wingspan (mm)
Rock Creek	Silver-haired bat	M	11.0	303
The Crater	Yuma myotis	M	8.0	250
Rock Creek Lake	Yuma myotis*			
"	Long-eared myotis*			
"	Hoary bat*			
"	Little brown bat*			
Queen's Gulch**	Big brown bat	M	16.5	344
"	Long-eared myotis	M	5.0	245
Muskrat Creek**	Long-eared myotis			

* Records with D.L. Genter, Montana Natural Heritage Program, Helena.

** Captured by Wendy Wilson and Betsy Fullman. Records unavailable.

Table 4. Bats captured on the Deerlodge National Forest, 1991.

Cave and Adit Surveys

A number of caves and mine adits were located and surveyed for evidence of bat use on the Deerlodge National Forest. Caves that were located and surveyed were:

West Fork Cave SW 1/4 NW 1/4 Sec 36 T6N R6W

Located on the West Fork of Rock Creek just north of State Highway 38 on state land about 1 1/2 miles west of the Rock Creek forks, this is a large shelter cave, about 10 feet high and 25 feet wide at the mouth, and 20 feet deep, with a steeply sloping back wall. There is a chamber to the right of the entrance that ends in about 15 feet. Some cracks in the walls and ceilings extend out of sight and could be used by bats for roosting. No evidence of bat use was found. The bat detector was employed for about an hour after dusk, at the mouth of the cave, and no bats were detected leaving the cave.

Maxville Cave NE 1/4 Sec 16 T8N R13W

Located in a limestone outcrop about 1/2 mile SE of the Boulder Creek road, and clearly visible above the trees, this cave is reached by a steep trail through Douglas fir forest. The opening is about 15 feet high and 3 feet wide. It opens into a room 15 feet deep with an extension that dead-ends within several feet and could be a bear den. No evidence of bat use was found. On September 8 two mist nets were set up near the entrance to this cave, and the bat detector was used

for 1 1/2 hours after dusk. No bats were heard or captured.

A few other small caves can be seen in limestone outcrops southeast of this cave within 1/2 mile, but these were not explored.

Wagner's Cave SW 1/4 Sec 23 T8N R13W

This cave is located in a limestone outcrop 3.6 miles southeast of Maxville and west of Boulder Creek. The entrance is barely visible from the road, just above the trees. It is necessary to cross beaver ponds, wade Boulder Creek, and climb a steep trail through Douglas fir forest, then ascend 25 feet of rock to reach the mouth of the cave. A chamber at the mouth of the cave quickly narrows to a 100 foot long horizontal passageway about 4 feet high and 5 feet wide that leads to the first room. From this point there is a series of chambers and passageways that extend perhaps 400 feet further.

Temperature = 50 F

Humidity = 85%

This cave was visited in July and in September. No evidence of bats was found. Because of the steep and difficult terrain to be negotiated, no attempt was made to haul the harp trap or bat detector to the cave, though it may be worthwhile.

Princeton caves Sec 30 T8N R12W

Three caves are visible high on a cliffside southeast of

Princeton and east of Boulder Creek. Spelunkers that have visited them found no evidence of bat use (Hanson and Madsen, pers. comm.).

The Crater NW 1/4 Sec 10 T8N R11W

Pikes Peak Creek siphons into a hole in a limestone wall and completely disappears. Across from this siphon is an overhang with a cave entrance about 4 by 4 feet that opens into a chamber about 15 feet deep, 25 feet wide, and 30 feet high. There are cracks in the ceiling that could harbor bats, though no evidence of bat use was found.

Temperature = 50 F

Humidity = 74%

This cave was visited in July and in September. In July, the harp trap was set up at the entrance to the cave, and a mist net was placed across the pond nearby. A bat detector was used near the entrance for two hours after dusk. No bats were captured. Five bats were observed flying through upper tree canopy at dusk, and 5 were heard in one hour on the detector, but none came out of the cave.

On September 9 the harp trap was set up in the entrance to the cave, and two mist nets were placed across the small the opening in front of the cave. The bat detector was used for 1 1/2 hours after dusk, near the mouth of the cave. One cruising *Myotis* was observed at dusk, and one was heard within an hour

after dusk, but neither came from the cave. One bat, tentatively identified as a *Myotis yumanensis* male, was captured in the harp trap as it exited the cave.

Hairy Lip Cave

The entrance to this cave is located in an old clear cut 3.8 miles west of the Storm Lake junction south of the Peterson Meadows road. Because the cave drops into a deep pit about 15 feet past the mouth of the cave, temperature and humidity were not taken. At dusk on August 5, one *Myotis* was seen leaving the cave mouth, and heading north, and another was heard with the bat detector in a 15 minute period. Mist nets were set up around the entrance but no bats were captured.

Spelunkers that have been down in the cave reported seeing no bats (G. Hanson and M. Madsen, pers. comm.).

This cave was again visited on September 25. The weather was clear and cold. The bat detector was used at the entrance for two hours. No bats were heard.

Garrity Cave

This cave is located on a high ridge northwest of Anaconda. An all-wheel drive vehicle is apparently necessary to reach this cave, thus it was not visited. Spelunkers that have been in

this cave did not notice bat evidence but it deserves to be investigated (G. Hanson and M. Madsen pers. comm).

Other caves

Several caves are located on a high ridge in the Pintlars south of East Fork Reservoir. These caves could not be located though they were searched for with the assistance of the Missoula Grotto spelunkers.

Mine Adits

Several mine adits were visited between Basin and Bernice. An adit north of the highway came to a dead end about 40 feet into the mountain. No bat evidence was observed. Temperature 54 degrees, humidity 59%.

An adit about 1 mile east of Bernice on the south side of the highway forked about 100 feet in. No bat sign was observed. The bat detector was used for 2 hours after dusk at the entrance. No bats were heard. Temperature 46 degrees, humidity 80%.

Two adits at the Bluebell Mine were searched for bat evidence. None was found. Two mist nets were set up near the entrance to one entrance, and the bat detector was used for 1 1/2 hours after dusk. No bats were captured or heard. Temperature 47 degrees, humidity 66%.

DISCUSSION

Survey methods

A study designed to determine absolute and quantitative abundance of a species is a census. Several methods, such as mark-recapture and visual counts (Thomas and LaVal 1988), have been used by researchers to estimate absolute bat numbers, but these have generally been in enclosed areas such as caves, or at specific roosting or maternity sites. Determining quantitative measures of bat densities in a given habitat or foraging within a given area is not considered possible with current technology (Findley 1993, Thomas and West 1989).

A survey is designed to provide relative and qualitative information, in short to "respon(d) to such questions as, Does habitat A have more bats of a given species than habitat B does? or Is species X more abundant before or after modification of habitat Y?" (Thomas and West 1989). Findley (1993) concluded that the best that can be done by a community ecologist studying bats is to assess the relative abundance of different species and to compare regions and habitats with respect to the numbers of bats obtained for given amounts of effort applied.

Summer roost counts, visual counts of foraging bats, ultrasonic detectors, vampire bites, and mist-netting and trapping were methods listed by Thomas and LaVal (1988) to estimate bat abundance in habitats or other geographic areas. The use of ultrasonic detectors

and mist-netting were selected as methods for this study as no summer roost sites were known in the study area prior to the study, there are no vampire bats, and visual counts are limited to a short time after dusk, prior to the time many species in Montana emerge from day roosts.

Species occurrence

One of the objectives of this study was to document the occurrence of bat species on the Deerlodge National Forest. There are 14 species of bats in Montana (Thompson 1982). Several of these are not expected to be on or near the Forest due to limited distribution in the state, such as the Spotted bat (*Euderma maculatum*) and the Pallid bat (*Antrozous pallidus*), both apparently restricted in Montana to the vicinity of the Pryor Mountains south of Billings (Worthington and Ross 1990). Most of the species known to inhabit the state, however, could potentially be found on the Forest. Documentation of both general species diversity, as well as the occurrence of species suspected of being relatively uncommon, such as Townsend's big-eared bat (*Plecotus townsendii*), is necessary for Forest planning and management, considering the mandates of federal legislation to manage for species diversity, and to maintain viable populations.

Though an experienced observer can identify many bat species visually by size, shape, and flight characteristics, when light conditions allow, documentation was not considered positive for this study

unless specimens were captured.

Capturing bats with mist nets incorporates several biases. In this study, nets were never more than 15 feet above the ground, and therefore selected against the capture of high flying foragers. Other bats, such as the Townsend's big-eared bat are slow, maneuverable flyers that can usually detect and avoid a mist net or a harp trap, and thus are difficult to document by capture with these techniques. All insectivorous bats are probably capable of detecting and avoiding mist nets using echo-location. Few bats are thus captured while foraging. Most bats captured are probably "commuting" along habitually used pathways on the way to or from foraging or watering areas (Thomas and West 1989). There is therefore an inherent site bias that cannot provide unequivocal information on the distribution of bats among sites or habitats using mist-nets as a survey method (Thomas and West 1989). Mist nets were used in this study to document species occurrence, while realizing that there are inherent biases in the method that select against the documentation of some species.

A potential problem with capture methods such as mist-netting is mis-identification of bat species. Most species in Montana can be identified easily using one of several available dichotomous keys, such as Van Zyll de Jong (1985). When there was any question of identification during this study, the bat in question was collected and taken to an expert for positive identification. Bats most easily

confused on the Deerlodge National Forest are the Fringed bat (*Myotis thysanodes*) with the Northern long-eared bat (*Myotis evotis*), and the Yuma bat (*Myotis yumanensis*), California myotis (*Myotis californicus*), and Little brown bat (*Myotis lucifugus*) complex.

Relative density

Relative density between sites and between habitats by different bat species can be determined using ultra-sonic bat detectors.

Discussions of the various types of ultrasonic detectors, along with their inherent strengths and weaknesses, can be found elsewhere (see Fenton 1988, and Thomas and West 1989). One or two tunable heterodyne detectors were used during this study. These detectors can be tuned to a number of frequencies, but can only scan a narrow band at one time. Detectors were normally set at 40 kHz during surveys, as most bats in Montana can be detected at that frequency. If a bat was heard long enough, an attempt was made to determine its lowest detectable frequency, as several species, or groups of species, can be identified using this characteristic.

The intensity of the echolocation call differs between species, as well as the frequency range of the call. This characteristic biases relative density information between species. Bats with intense vocalizations, such as Hoary bats (*Lasiurus cinereus*) or Big brown bats (*Eptesicus fuscus*), are much more likely to be detected than those with weaker vocalizations, such as Townsend's big-eared bat. *Myotis* species fall between these extremes in intensity of their

vocalizations. In effect, the effective area sampled by the detector is much larger for the strong emitters than for the moderate or weak emitters. Thus, direct comparisons of relative density between species based solely on bat detector results is unwise.

Though some effort was made to determine species heard with bat detectors, the observers were not experienced enough to feel confident in the accuracy of their identification. Considering this and the inherent bias discussed above, no effort was made during this study to determine relative density of bats between species, or of species at specific sites.

Habitat use

To analyze the use of various habitats, and the importance of various components of these habitats within the Deerlodge National Forest, bat use was determined from the results of surveys conducted with ultrasonic bat detectors. Bat use was defined as "bat passes per hour," as heard on a bat detector. An observer cannot generally differentiate between one bat passing several times, and several bats passing once, so the measurement is quite relative. No attempt was made to determine species; all bat echolocation calls detected were recorded and used as a measure of relative density. Bat activity was arbitrarily assigned to categories of high (more than 10 passes per hour), moderate (5 to 9 passes per hour), and low (less than 5 passes per hour). This classification is completely arbitrary, and is based on results that occurred across the Deerlodge National Forest during

1991. As noted in the Results section, of 30 hours of transects run during 1991, only 10% recorded more than 21 bats per hour, and about 85% had less than 10 bats per hour. In other localities 10 or even 60 bat passes per hour may be considered low activity, but these categories will serve for the analysis of relative habitat use on the Deerlodge.

Assuming that the degree of bat activity associated with a site correlates with the preference by bats for some component of the habitat of that site, analysis of bat activity by habitat component should indicate which components bats appear to be selecting for, or against. For instance, 60 percent of the sites surveyed in which beaver ponds were a component of the habitat had high bat activity, while another 20% had moderate activity (Table 2). Of sites with mature Douglas fir, 33% had high activity and 17% moderate activity. No sites with lakes or clearcuts had high activity, but 100% of those sites with clearcuts had moderate activity and 67% of the sites with lakes had moderate activity. Combining features, 63% of those sites surveyed that had both nearby rock outcrops and riparian areas had high or moderate activity, and 46% of the sites with riparian areas and either Douglas fir or mature hardwoods had high or moderate activity (Table 2).

The habitat components at which a third or more of the sites featuring that component had high bat activity were: beaver ponds (60%), rock outcrops (45%), mature hardwoods (38%), and mature

Douglas fir (33%). Features at which a third or more of the sites with that component had moderate activity were: clearcuts (100%), lakes (67%), and lodgepole pine (36%) (Table 2).

Of those sites that had high bat activity, 100% of them had rock outcrops nearby, 100% had riparian areas nearby, 100% of them had riparian areas with either Douglas fir or mature hardwoods, or riparian areas with rock outcrops nearby (Table 3). Components that were part of the habitat at half or more of the sites with high bat activity, in addition to those mentioned, were beaver ponds (60%), mature Douglas fir (80%), and mature hardwoods (66%). No sites with high bat activity had caves or lakes nearby, though a third of the sites with moderate activity had caves or lakes nearby (Table 3).

In a study of forest bats in Oregon and Washington, all species except the Silver-haired bat (*Lasionycteris noctivagans*) in Washington, were detected at dramatically higher rates in old-growth stands than in young or mature stands of Douglas fir (Thomas and West 1991). Bats were between 2.5 and 9.8 times more abundant in old-growth than in young or mature stands in both regions. Thomas and West (1991) speculated that the activity of the *Myotis* species, the Big brown bats, and the Silver-haired bats in Oregon were more abundant in old-growth because that habitat provided an increased variety and abundance of day roosts.

Perkins and Cross (1988) reported that all of the Hoary bats and most

of the Silver-haired bats in their study roosted in old-growth Douglas fir. They speculate that Hoary bats prefer these older trees because they roost in foliage, and older trees provide a combination of shelter, open space to gain flight when leaving the roost, and immediate accessibility upon return. Silver-haired bats appear to prefer older Douglas fir trees because the bark tends to pull away from the bole providing crevices for shelter. Older trees are also may provide roosting crevices or cavities created by wind and lightning damage, shed limb holes, excavations by cavity nesting birds, cracks in the wood, and so on (Perkins and Cross 1988). Old-growth ponderosa pine provided some roosting sites, but was not selected as often by bats as old-growth Douglas fir because bark ridges are not as deep and bark exfoliation is not as common in ponderosa pine (Perkins and Cross 1988).

Bats may roost in numerous sites within a forest exclusive of old-growth timber. Old buildings, including recreational cabins and buildings associated with abandoned mines, provide favored sites for some species, including the Little brown bat and the Big brown bat (Fenton 1992), but these are often unavailable in much of the forested west. Caves and adits may provide roosting sites for many species of bats (Fenton 1992). Many of the *Myotis* species including the Fringed bat, the California myotis, and the Small-footed bat (*Myotis ciliolabrum*), have been found roosting in fissures and under rock slabs (Thomas and West 1986).

Thomas and West (1991) reported that, although old-growth stands of timber had much greater bat activity than other forest stands, *Myotis* species did not appear to forage there. In some cases, they reported, feeding rates were dramatically greater over water. Though insect density was similar in forested and lacustrine habitat, Lunde and Harestad (1986) found bat activity 75 times greater in the lacustrine habitat. They reported no bat activity in cutover forest though insects were abundant in that habitat.

Cave and adit surveys

Seven caves and several abandoned mine adits on the Deerlodge National Forest were searched for evidence of bat use during the summer of 1991. No summer roosting sites were located in these caves or adits. However, bats could be using any of these as autumn swarming locations, or winter hibernacula, and this possibility cannot be ruled out until all are surveyed at appropriate times (in southwestern Montana, late September to mid-October for elevations above 6000', 3 weeks later for lower elevations).

SUMMARY

Six species of bats, representing four genera, were documented by capture during this phase of the study. These were the Big brown bat (*Eptesicus fuscus*), the Little brown bat (*Myotis lucifugus*), the Yuma bat (*Myotis yumanensis*), the Long-eared myotis (*Myotis evotis*), the Hoary bat (*Lasiurus cinereus*), and the Silver-haired bat (*Lasionycteris noctivagans*).

Relative bat densities varied between habitats. Those with rock-outcrops, beaver ponds, mature hardwoods, mature Douglas fir, or riparian areas nearby had the greatest bat activity.

Findley (1993) stated that an increase in species richness accompanies increased availability of roosts. "Forested regions lacking cliffs, caverns, and caves support fewer species, and those that do occur are known to use trees as daytime roosts in summer. Mountainous, broken topography with opportunities for roosting in crevices, cliff faces, caverns, and caves support richer communities" (Findley 1993).

Management prescriptions that maintain undisturbed stands of old-growth forest, especially old stands of Douglas fir and mature hardwoods, the maintenance of healthy riparian areas, and the preservation of caves and access to abandoned mine adits will provide roosting and foraging habitat for a diversity and abundance of bats. Management activities that promote large lodgepole pine stands, and even-aged management will not.

LITERATURE CITED

- Anthony, E.L.P. 1988. Age determination in bats. *In* Ecological and behavioral methods for the study of bats. T.H. Kunz *Ed.* Smithsonian Institution Press, Washington, D.C. 533 pp.
- Campbell, N.P. 1978. Caves of Montana. Bulletin 105, State of Montana Bureau of Mines and Geology, Butte. 169 pp.
- Fenton, M.B. 1988. Detecting, recording, and analyzing vocalizations of bats. *In* Ecological and behavioral methods for the study of bats. T.H. Kunz *Ed.* Smithsonian Institution Press, Washington, D.C. 533 pp.
- Fenton, M.B. 1992. Bats. Facts on File. New York, NY. 207 pp.
- Fenton, M.B. and G.P. Bell. 1981. Recognition of species of insectivorous bats by their echolocation calls. *J. Mammal.*, 62:233-243.
- Finch, D.M. 1992. Threatened, endangered, and vulnerable species of terrestrial vertebrates in the Rocky Mountain Region. Gen. tech. rpt. RM-215. USDA Forest Service, Rocky Mountain Forest and Range Experiment Station, Fort Collins. 38 pp.
- Findley, J.S. 1993. Bats: a community perspective. Cambridge Univ. Press, Cambridge.
- Genter, D.L. 1993. Animal species of special concern. Montana Natural Heritage Program, Helena. 11 pp.
- Hill, J.E. and J.D. Smith. 1984. Bats: a natural history. Univ. Texas Press, Austin. 243 pp.
- Hoffman, R.S. and D.L. Pattie. 1968. A guide to Montana mammals: identification, habitat, distribution, and abundance. Univ. Montana, Missoula.
- Kunz, T.H. and A. Kurta. 1988. Capture methods and holding devices. *In* Ecological and behavioral methods for the study of bats. T.H. Kunz *Ed.* Smithsonian Institution Press, Washington, D.C. 533 pp.
- Lunde, R.E. and A. S. Harestad. 1986. Activity of little brown bats in coastal forests. *Northwest Science* 60:206-209.
- Mumma, J. 1991. Updated Northern Region sensitive species list. Unpubl. memo. Northern Region, USDA Forest Service, Missoula.

- Racey, P.A. 1988. Reproductive assessment in bats. *In* Ecological and behavioral methods for the study of bats. T.H. Kunz *Ed.* Smithsonian Institution Press, Washington, D.C. 533 pp.
- Thomas, D.W. and R.K. LaVal. 1988. Survey and census methods. *In* Ecological and behavioral methods for the study of bats. T.H. Kunz *Ed.* Smithsonian Institution Press, Washington, D.C. 533 pp.
- Thomas, D.W. and S.D. West. 1986. Forest age associations of bats in the southern Washington Cascades and Oregon Coast Range. Final rep. PNW-84-234. Forest Sciences Laboratory, Univ. Wash., Seattle.
- Thomas, D.W. and S.D. West. 1989. Sampling methods for bats. Gen. tech. rep. PNW-GTR-243. Pacific Northwest Res. Sta., USDA Forest Service, Portland.
- Thomas, D.W. and S.D. West. 1991. Forest age associations of bats in the southern Washington Cascade and Oregon Coast ranges. *In* Wildlife and vegetation of unmanaged Douglas-fir forests. Pacific Northwest Res. Sta., USDA Forest Service, Portland.
- Thompson, L.S. 1982. Distribution of Montana amphibians, reptiles, and mammals. MT Audubon Council, Helena.
- Tuttle, M.D. 1974. An improved trap for bats. *J. Mammal.*, 55:475-477.
- van Zyll de Jong, C.G. 1985. Handbook of Canadian mammals:bats. National Museum of Canada, Ottawa. 212 pp.
- Worthington, D.J. and H.N. Ross. 1990. Abundance and distribution of bats in the Pryor Mountains of south central Montana. MT Natural Heritage Program, Helena.

APPENDIX I.

MTNHP 92/2-1

BAT SURVEY FIELD FORM

DATE: _____

LOCATION: _____

LEGAL DESCRIPTION: _____

WEATHER:

(start/time)

(finish/time)

TEMPERATURE

WIND

CLOUD COVER

HUMIDITY

SITE CHARACTERISTICS:

VEGETATION (tree and shrub species, canopy coverage, size, density, distribution) -

WATER (stream width, depth, speed, bank cover, pond or lake size, emergent vegetation) -

LOCAL GEOLOGY (rock type, extent of outcrops or cliffs) -

CAVES OR ADITS (in vicinity?, status: surveyed?)

Note: if bat survey is at a specific cave or adit, describe here and complete a cave inventory form)

MIST NET (OR TUTTLE TRAP) RESULTS:

Number and sizes of mist nets set: ____ 18' ____ 30' ____ 42' ____ 60' ____ other ()

How/where set (trail, stream, canopy, pond, meadow, cave entrance, etc - record number and setting):

Tuttle trap used? Y / N

Where set: _____

APPENDIX I (cont.).

MTNHP 92/2-2

Bats captured Y/N (Species, sex and number):

For each bat captured, record:

SPECIMEN NUMBER: _____ DATE: _____ LOCATION: _____

TIME of CAPTURE: _____ County, MT

1) Species: _____

2) Sex: M F Un 3) Age: Ad Juv Un

4) Reprod status: F: Lac/Non Lac, Grav/Postpartum, Unkn None; M: Scrotal/Nonsrot

5) Weight: _____ grams. Forearm length: _____ mm. Other specific characteristics: _____

6) Comments (net type and height, condition of bat and markings/scars, collected or released):

* * * * *

For each bat captured, record:

SPECIMEN NUMBER: _____ DATE: _____ LOCATION: _____

TIME of CAPTURE: _____ County, MT

1) Species: _____

2) Sex: M F Un 3) Age: Ad Juv Un

4) Reprod status: F: Lac/Non Lac, Grav/Postpartum, Unkn None; M: Scrotal/Nonsrot

5) Weight: _____ grams. Forearm length: _____ mm. Other specific characteristics: _____

6) Comments (net type and height, condition of bat and markings/scars, collected or released):

* * * * *